UNIVERSITI SAINS MALAYSIA

2nd. Semester Examination
2002/2003 Academic Session
Peperiksaan Semester Kedua
Sidang Akademik 2002/2003

February / March 2003

EAV 582/4-Wastewater Engineering And Water Pollution Control
(Kejuruteraan Air Sisa dan Kawalan Pencemaran Air)

Time : 3 hour
Masa : 3 jam

Instruction to candidates:
Arahan Kepada Calon :

1. Ensure that this paper contains **EIGHT (8)** printed pages include appendices.
1. *Sila pastikan kertas peperiksaan ini mengandungi **LAPAN (8)** muka surat bercetak termasuk lampiran sebelum anda memulakan peperiksaan ini.*

2. This paper contains **SIX (6)** question. Answer **FIVE (5)** question only. Marks will be given to the **FIRST FIVE (5)** question put in order on the answer script and **NOT** the **BEST FIVE (5)**
2. *Kertas ini mengandungi **ENAM (6)** soalan. Jawab **LIMA (5)** soalan sahaja. Markah hanya akan dikira bagi **LIMA (5)** jawapan **PERTAMA** yang dimasukkan di dalam buku mengikut susunan dan bukannya **LIMA (5)** jawapan terbaik.*

3. All questions carry the same mark.
3. *Semua soalan mempunyai markah yang sama.*

4. All questions **CAN BE** answered either English or Bahasa Malaysia or combination of both languages..
4. *Semua soalan boleh dijawab dalam Bahasa Inggeris atau Bahasa Malaysia ataupun kombinasi kedua-dua bahasa.*

5. Write answered question number on the cover sheet of answer script.
5. *Tuliskan nombor soalan yang dijawab di luar kulit buku jawapan anda.*

...2/-

1. (a) Give **FOUR (4)** advantages of a separate sewer system that is practiced in most countries as compared to a combined system.

(4 marks)

*(a) Berikan **EMPAT (4)** kebaikan sistem pembetungan terasing yang diamalkan di kebanyakan negara berbanding sistem bergabung.*

(4 markah)

(b) A town is receiving a peak water supply of 20 MGD (90,000 m^3/day). Design a separate cast iron sewer which flows 70% full, if ratio of sewage to supplied water is 0.75. Allowable slope is 1:650.

(10 marks)

(b) Sebuah bandar menerima bekalan air puncak sebanyak 20 MGD (90,000 m^3/hari). Reka bentukkan pembetung terasing jenis besi tuang yang mengalir 70% penuh bagi bandar ini sekiranya nisbah air sisa ke air dibekal adalah 0.75. Kecerunan pembetung yang dibenarkan adalah 1:650.

(10 markah)

(c) Design a septic tank for treating wastewater from 3 bungalow houses and 2 shop lots in Kerian District. These shops are having an individual area of 800 m^2. Assume length to width ratio is 3:1, depth 1.5 m and retention time 1 day.

(6 marks)

(c) Reka bentukkan suatu tangki septik untuk mengolah air sisa dari 3 unit rumah bungalow serta 2 unit rumah kedai di Daerah Kerian. Kedai ini mempunyai keluasan masing-masing 800 m^2. Anggap nisbah panjang ke lebar sebagai 3:1, kedalaman 1.5 m dan masa tahanan 1 hari.

(6 markah)

2. (a) Explain in brief principles of a trickling filter in wastewater treatment.

(4 marks)

(a) Terangkan secara ringkas prinsip turas cucur dalam olahan air sisa.

(4 markah)

(b) Given that the value of BOD_5 load for Taman Anggun in Ipoh is 150 kg/day. This Taman is having a total of 200 houses and a mosque which can accommodate 200 person. Suggest a suitable surface area of an aerated lagoon if the depth is 3 m and the Volumetric Organic Loading is 0.25 kg BOD_5/m^3.day.

(4 marks)

(b) Diberi bahawa nilai beban BOD_5 untuk Taman Anggun di Ipoh adalah 150 kg/hari. Taman ini mempunyai jumlah rumah sebanyak 200 buah serta sebuah mesjid yang boleh memuatkan seramai 200 orang. Cadangkan luas permukaan lagun terudara yang sesuai sekiranya kedalaman adalah 3 m dan nilai Beban Organik Isipadu 0.25 kg BOD_5/m^3.hari.

(4 markah)

...3/-

(c) A housing scheme with a Population Equivalent of 500 is having a BOD load per capita of 0.045 kg/day. Determine the suitable dimension of a facultative pond for treating this wastewater if the Aerial Organic Loading is 0.050 kg BOD/m^2.day and the retention time is 20 days. Take length to width ratio as 3:1.

(6 marks)

(c) Suatu skim perumahan dengan nilai Penduduk Setara 500 orang mempunyai beban BOD per kapita sebanyak 0.045 kg/hari. Tentukan dimensi kolam pengoksidaan yang sesuai untuk mengolah air sisa ini sekiranya Beban Organik Kawasan adalah 0.050 kg BOD/m^2.hari dan masa tahanan 20 hari. Ambil nisbah panjang ke lebar sebagai 3:1.

(6 markah)

(d) Discuss the main physical and chemical characteristics of wastewater and their importance in the treatment system.

(6 marks)

(d) Bincangkan ciri-ciri fizikal dan kimia air sisa yang utama dan kepentingannya dalam sistem olahan.

(6 markah)

3. (a) Name **THREE (3)** main types of pump, normally used in wastewater industry.

(3 marks)

*(a) Namakan **TIGA (3)** jenis utama pam yang biasanya digunakan oleh industri air sisa.*

(3 markah)

(b) Design a suitable pump sump at peak flow for a housing scheme with following data:

(b) Reka bentukkan suatu kebuk pam yang sesuai pada kedaralir puncak untuk suatu skim perumahan dengan data yang berikut:

Table 1: Design data

Type of premises	Data
Single storey medium cost	1,000
Double storey semi-detached	500
Double storey shop lots Ground floor – 6.1m x 12.65m First floor – 6.1m x 15.54m	50
Petrol station	1
Daily school without hostels @ 1,500 pupils	1
Mosque @ 1,000 people	1
Dry market @ 30 shops	1

Take retention time at Q_{peak} as 30 minutes.

(7 marks)

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(c) Write short notes on :

i. Determination of terminal velocity of a discrete particle in waste water following Newton's law.
ii. Coagulation and flocculation.
iii. Rotating biological contactor.

(10 marks)

(c) Tuliskan nota ringkas untuk :

i. Penentuan halaju terminal untuk zarah diskret dalam air sisa mengikut hukum Newton.
ii. Penggumpalan dan pengelompokan.
iii. Penyentuh biologi berputar.

(10 markah)

4. (a) Write down the importance of Grit Chambers and Primary Sedimentation Tanks in wastewater treatment plants.

(2 marks)

(a) Tuliskan kepentingan kebuk kersik dan tangki enap primer di loji olahan air sisa.

(2 markah)

(b) Discuss operating functions and typical design informations of various types of Grit Chambers and Primary Sedimentation Tanks which are commonly used in wastewater engineering practice.

(8 marks)

(b) Bincangkan fungsi operasi dan maklumat reka bentuk tipikal berbagai jenis kebuk kersik dan tangki enap primer yang biasanya terdapat di dalam praktis kejuruteraan air sisa.

(8 markah)

(c) The average flowrate at a municipal wastewater treatment plant is 40,000 m^3/d. The highest observed peak daily flowrate is 70,000 m^3/d. Design a rectangular primary sedimentation tank with width 10 m, sidewater depth 4.5 m and overflow rate of 50 $m^3/m^2.d$ at average flow. Calculate :

i. Length of the tank
ii. Retention time at average flowrate
iii. Retention time at peak flowrate
iv. Overflow rate at peak flow
v. Scour velocity to determine if settled material will become resuspended.

(10 marks)

(c) Kadaralir purata di sebuah loji olahan air sisa perbandaran adalah 40,000 m^3/hari. Reka bentukkan tangki enapan primer segiempat dengan lebar 10 m, kedalaman tepi 4.5 m dan kadar limpah 50 m^3/m^2.hari pada kadaralir purata. Kirakan :

i. Panjang tangki
ii. Masa tahanan pada kadaralir purata
iii. Masa tahanan pada kadaralir puncak
iv. Kadar limpah pada kadaralir puncak
v. Halaju kerukan untuk menentukan samada bahan-bahan teruap akan terampai semula

(10 markah)

5. (a) Develop a mass balance equation for microorganisms in a completely mixed activated sludge process with cellular recycle and wasting from the reactor.

(2 marks)

(a) Terbitkan persamaan keseimbangan jisim untuk mikroorganisma dalam proses enap cemar teraktif tercampur menyeluruh dengan kitar semula sel dan pensisaan (wasting) dari reaktor.

(2 markah)

(b) Show that mass concentration of microorganism in a reactor is related to average solids retention time, hydraulic retention time, maximum yield coefficient, substrate concentration in influent and effluent of reactor and endogenous decay coefficient.

(8 marks)

(b) Tunjukkan bahawa kepekatan jisim mikroorganisma dalam sesuatau reaktor adalah berhubungkait dengan masa tahanan purata pepejal, masa tahanan hidraulik, koefisi maximum 'yield', kepekatan substrat dalam influen dan efluen reaktor dan koefisi 'endogenous decay'.

(8 markah)

(c) A completely mixed activated sludge process is designed to treat 20,000 m^3/d of wastewater with influent soluble BOD_5 of 350 mg/L. The effluent soluble BOD_5 is 15 mg/L and ambient temperature is 20°C. Determine :

i. The reactor volume
ii. Overall plant efficiency
iii. Wasting rate from the reactor
iv. Food : microorganism ratio
v. Specific substrate utilization rate

(10 marks)

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Data :
Influent volatile suspended solids to reactor is negligible

Maximum yield coefficient	-	0.4 g/g
Mixed liquor volatile suspended solids	-	3500 mg/L
Average solids retention time	-	10 days
Endogenous decay coefficient	-	0.06 day^{-1}
Volatile suspended solids in effluent	-	20 mg/L

(c) *Suatu proses enap cemar teraktif tercampur menyeluruh direkabentuk untuk mengolah 20,000 m^3/hari air sisa dengan nilai BOD larut agihan 350 mg/L. Nilai BOD larut efluen adalah 15 mg/L dan suhu ambien 20°C.*

Tentukan :

i. Isipadu reaktor
ii. Kecekapan keseluruhan loji
iii. Kadar pensisaan (wasting rate) dari reaktor
iv. Nisbah makanan : mikroogranisma
v. Kadar penggunaan substrat spesifik

Data :
Pepejal Terampai Meruap Influen ke reaktor boleh diabaikan.

Koefisi maksimum 'yield'	-	*0.4 g/g*
Pepejal Terampai Meruap Likur Tercampur	-	*3500 mg/L*
Masa tahanan purata pepejal	-	*10 hari*
Koefisi 'endogenous decay'	-	*0.06 $hari^{-1}$*
Pepejal Terampai Meruap di efluen	-	*20 mg/L*

(10 markah)

6. (a) Write down with flow diagram the generalized steps which are followed for treatment, disposal and reuse of sludge.

(5 marks)

(a) Tuliskan dengan rajah kadaralir, langkah-langkah umum untuk olahan, pelupusan dan guna semula enap cemar.

(5 markah)

(b) Discuss various methods of thickening, stabilization and anaerobic digestion whih are commonly followed in sludge processing.

(15 marks)

(b) Bincangkan kaedah-kaedah pemekatan, penstabilan dan pencernaan anaerobik yang biasanya diamalkan dalam pemprosesan enap cemar.

(15 markah)

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APPENDICES

(Adapted from MS 1228 : 1991 : MALAYSIAN STANDARD: Code of Practice for Design and Installation of Sewerage Systems) and Guidelines for Developers, Seksyen 1 and 2, 1995

Table B.1 Recommended Population Equivalent Factors

Type of Premise/Establishment	Population Equivalent (recommended)
Residential	5 per house
Commercial (includes offices, shopping complex, entertainment/ recreational centres, restaurants, cafeteria, theaters)	3 per 100 m^2 gross area
Schools/Educational Institutions: – Day schools/institutions – Fully residential – Partial residential	 0.2 per student 1 per student 0.2 per student for non residential student and 1 per student for residential student
Hospitals	4 per bed
Hotels (with dining and laundry facilities)	4 per room
Factories (excluding process water)	0.3 per staff
Market (wet type)	3 per stall
Petrol Kiosks/Service Stations	18 per service bay
Bus Terminal	4 per bus bay
Taxi Terminal	4 per taxi bay
Mosque	0.5 per person
Church/Temple	0.2 per person
Stadium	0.2 per person
Swimming Pool/Sports Complex	0.5 per person
Public Toilet	16 per wc
Type of Premise/Establishment	Population Equivalent (recommended)
Airport	0.2 per passenger 0.3 per employee
Laundry	10 per machine
Prison	1 per person
Golf Course	20 per hole

* Water Consumption Rate is 225 Liter/capita.day

APPENDICES

Table 1 : Coefficient Manning

Sewer Type	n
Smooth metal	0.010
Asbestos pipe	0.011
Concrete	0.014
Cast iron pipe	0.015
Smooth clay or gravel	0.018-0.020
Natural channel	0.025-0.35+

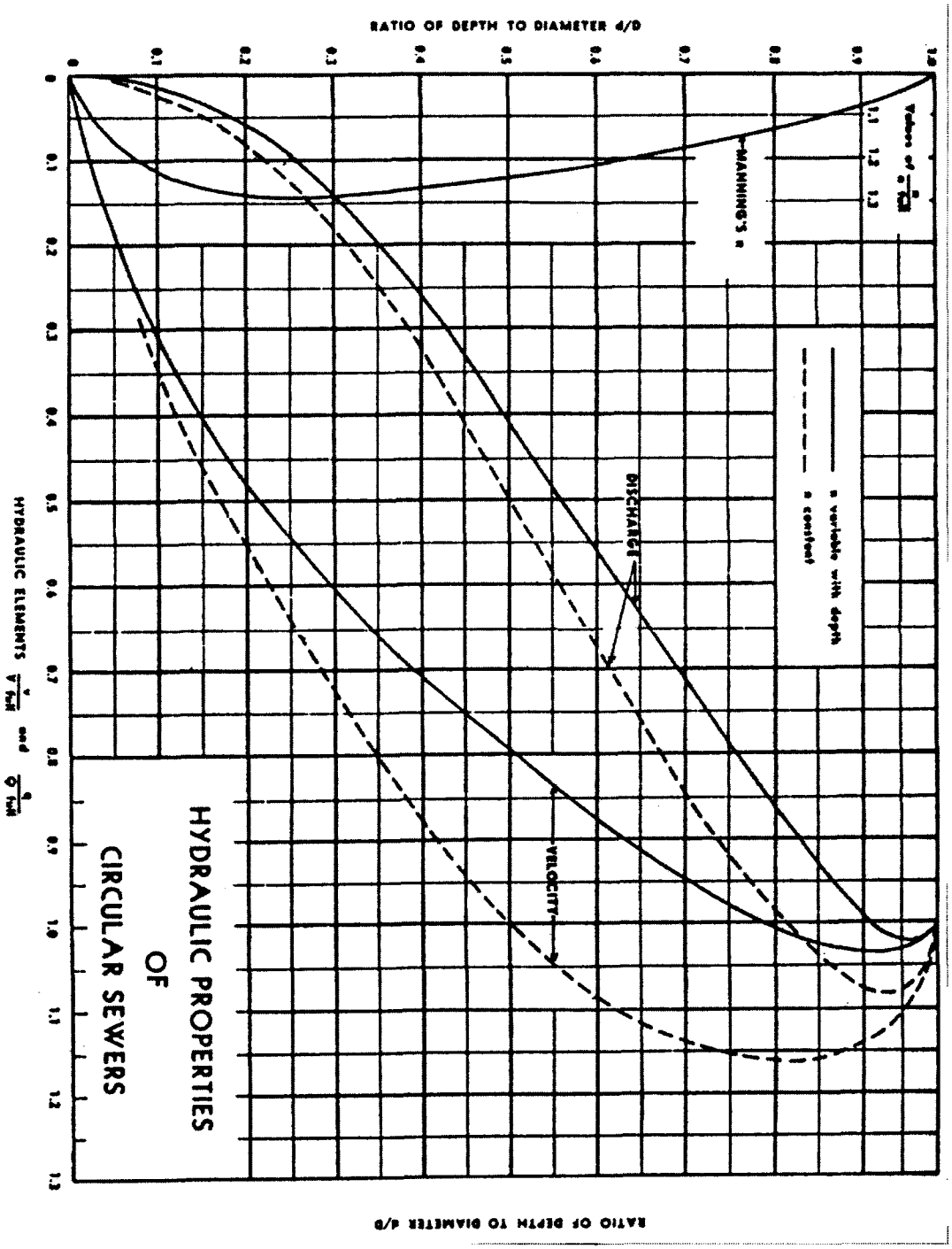

Figure 1 : Manning Chart